McGuire
Environmental
Consultants, Inc.

"Quality services that ensure safe drinking water"

June 12, 1998

Dr. John G. Catts
Harding Lawson Associates
30 Corporate Park, Suite 400
Irvine, CA 92606

Dear Dr. Catts:

Thank you for the opportunity to review your draft report entitled "Phase 1 Treatability Study Draft Report Perchlorate in Groundwater Baldwin Park Operating Unit San Gabriel Basin" and the Phase 2 experimental design document. Attached are my comments on the reports. I think the report does a good job describing the biological process and its ability to remove perchlorate (and nitrate). However, the report does a poor job of illustrating how the process would fit into a water plant treatment train. I believe more work should be done to see if the possibly serious problems with disinfection by-product formation could be resolved before the demonstration-scale project is built. If the organic products from the reactor are significant precursors for the formation of disinfection by-products, the entire process may not be viable.

I would be glad to discuss my comments with you at any time. If I can be of any further assistance, please give me a call.

Very truly yours,

Michael J. McGuire

Michael J. McGuire, Ph.D.

Cc: C. Williams/R. Sase
R. Bowcock
J.-M. Bruno
W. Praskins

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Review of Reports Entitled "Phase 1 Treatability Study Draft Report Perchlorate in Groundwater Baldwin Park Operating Unit San Gabriel Basin" and "Phase 2..."

I have several concerns with the reports' conclusions and with the presentation of some of the data. I have divided my general comments into topics as noted below.

Organic By-products of GAC/FB Process

Only a limited number of organics were monitored for in the reactor effluent. Because a biological process of any kind (and especially one conducted in anoxic conditions) can produce a wide variety of organic compound by-products, it is important to look for a wide variety of organics. Equations on pages 6 and 9 in the text are not correct because they grossly oversimplify the reactions taking place. A lot more material than carbon dioxide and water are produced in the reactor. Not only is cellular material being produced as a result of using ethanol as a carbon source, but also a wide variety of bacterial metabolic by-products such as aldehydes, ketones and organic acids may be produced. While not mentioned in the text, the data tables in Appendix D show the production of several hundred micrograms per liter of acetone in the reactor effluent. Broad-scan analytical methods for more polar organic compounds should be used to identify the by-products of ethanol degradation and cell metabolism and growth. Derivatization techniques followed by GC/MS and liquid chromatography/mass spectroscopy (LC/MS) should be used to identify these organic compounds and quantify their amounts.

More volatile organic compounds (VOCs) must be analyzed for in the reactor effluent. It is unlikely that the disappearance of VOCs noted in Appendix D means that the compounds were biologically converted to carbon dioxide and water. Results for only a limited number VOCs are listed in Appendix D. A purge-and-trap isolation methodology followed by GC/MS with compound identification and quantification should be carried out at maximum process efficiency and at sub-maximum process efficiency such as during start up. The investigators may wish to do a preliminary scan with purge-and-trap/GC with an electron capture detector (ECD) to screen for halogenated volatile organic by-products.

It is most important that an analytical method with a very low (low ppb) method detection level be used to analyze for ethanol (and methanol, for that matter). A level of "less than 5 mg/L" will not be acceptable to the public. The actual level of ethanol must be quantified in the reactor effluent.

This biological process is undoubtedly producing food that other microorganisms could use in an aerobic environment such as a water utility distribution system. Acetone which is acknowledged to be produced during perchlorate reduction in the GAC/FB reactor will act as a food source. The investigators should have taken samples from the reactor influent and effluent and submitted them for Assimilable Organic Carbon (AOC) or Biodegradable Organic Carbon (BDOC) analysis. These tests have been able to estimate the amount of "food" that the ozonation process can produce when it oxidizes natural organic matter. Also, there is not even any total organic carbon (TOC) data from the study. The reader does not even know if there is a net production of TOC through the process (as compared to the groundwater values). BOD and COD do not even begin to address the issue of organic production in the process. The distribution system downstream of the treatment process could be subject to regrowth of bacteria if a high concentration of food is passed into it.

Disinfection By-Products (DBPs)

I was very surprised to note that the critical issue of disinfection by-product production was not addressed in the Phase 1 study in even a cursory manner. Given the amount and type of organics present in the reactor effluent (especially as noted by the increase in acetone), it is expected that chlorination of the reactor effluent will produce hundreds of ppb of trihalomethanes and other DBPs. The authors stated that the effluent met all Title 22 parameters, but I did not see any THM or other DBP data. Therefore, we do not know if the reactor (followed by chlorination and filtration) can meet drinking water standards or not. This must be addressed before the process can be considered for use in a drinking water distribution system. The work plan for Phase 2 mentions collecting data on DBPs but not much detail is provided. I recommend analyzing for the same DBPs as are monitored for in the Information Collection Rule after the chlorination step that is sufficient to kill the resident bacteria (see discussion below).

Secondary Drinking Water Standards

Utilities must not only meet primary drinking water standards but they must also produce water that is aesthetically acceptable to its customers. At no place in the reports is there a discussion of the taste and odor or color characteristics of the water. A Flavor Profile Panel should assess the taste and odor quality of the reactor product water.

Microbiological Quality of the Reactor Effluent

The report deals in only passing fashion with the issue of microbiological quality of the reactor effluent. There is an error on page 13 where an "upper quantifiable limit" for coliforms is stated to be 200.5. In fact, much higher concentrations of coliforms can be determined if the dilutions tested are properly planned. Also, there are limited total plate count bacteria levels (or at least that is what they appear to be) in Appendix D. They are not discussed in the text. All of the data indicate that a significant and potentially troublesome level of bacteria are shed by the reactor and end up in the reactor effluent.

The report assumes that disinfection with chlorine and filtration will fix the biological problem, but they do not discuss any of the treatment process integration or confounding issues. For example, it may be necessary to operate the filter in a " biologically active" mode to remove the organics created by the GAC/FB reactor. If so, chlorination must follow the filter and not precede it as noted in the experimental plan for Phase 2. Also, adding chlorine at the level to kill the bacteria could cause production of very high levels of DBPs given the production of precursors I referred to above.

Chlorination after the filter is also a good idea because the clumps of bacteria will likely be removed in the filter. Clumping of bacteria has been demonstrated by many researchers to impede the action of disinfectants like chlorine. The bacteria in the center of the clump can be protected by the bodies of the surrounding bacteria. It is important to remove or kill the majority of bacteria before the water is put into a distribution system to avoid "seeding" the system with coliforms or other nuisance organisms.

Parameter Selection and Data Presentation

Measuring BOD and COD as parameters for understanding the process is not advisable. Total organic carbon (TOC) and ultraviolet absorbance at 254 nm (UV254) are much more relevant to drinking water treatment.

It would be easier for the reader to assess the importance of elevated perchlorate levels in the reactor effluent on plate 3 if the y-axis began at zero as it does for all the other graphs. Also, the method detection level (MDL) should be noted on the various graphs to put the "plateauing" or "steady-state" effect on the graphs in perspective.

Reactor Response after Process Upset

The report clearly documents that the biological reactor is subject to upset during power outages or interruptions in the chemical feeds. Recovery times were on the order of days. Unit processes used in water treatment must be reliable a very high percentage of the time or backup systems must be in place to deal with process upsets. There is no discussion of this in the report which I believe is a major weakness and should be corrected. If backup systems will have to be included in a full-scale system, that will adversely affect the economics of the treatment process.

Summary

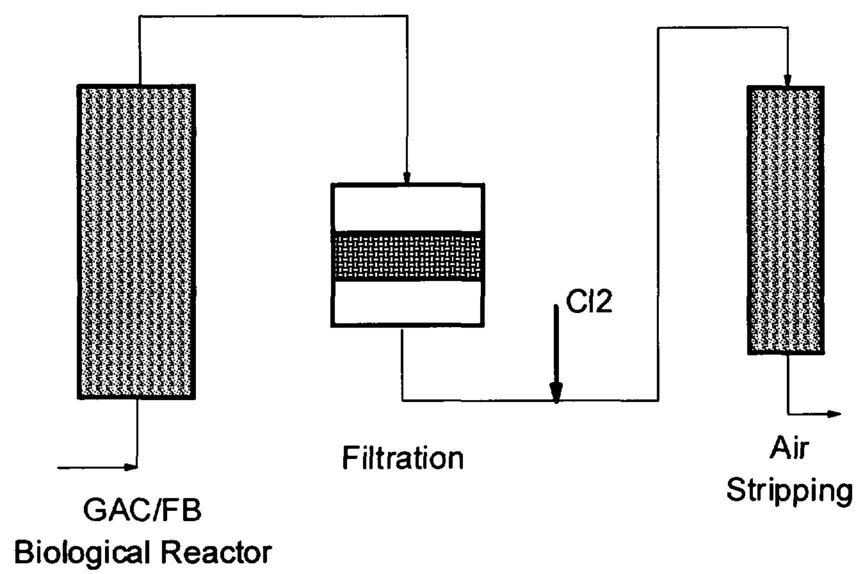
I do not believe that the study has demonstrated that filtration and disinfection that the water produced by the treatment train will meet "potable standards." A number of parameters included in Title 22 were not analyzed and no assessment of DBP formation was performed. Also, no assessment of the secondary maximum contaminant levels has been done. Consumers will reject the water produced by the reactor if it is colored, has a bad odor or an off-taste. The authors can only speculate on compliance with Title 22 since they have not done the work.

Recommendation

Before Aerojet and La Puente Water District go to the expense of a demonstration-scale test of the technology, I recommend that the pilot plant in Sacramento be restarted and additional analyses be conducted (see above discussion topics). I believe more work should be done to see if the possibly serious problems with disinfection by-product formation could be resolved before the demonstration-scale project is built. If the organic products from the reactor are significant precursors for the formation of disinfection by-products, the entire process may not be viable.

Should the DBP tests prove to be satisfactory, I recommend that an alternate arrangement of unit processes be considered. Figure 1 below shows the filtration process following immediately after the biological reactor with chlorination (or disinfection) following after that and preceding the air stripper. This arrangement will allow further removal of organics on a biologically active filter (an oxygen source may have to be added prior to filtration). In addition, the majority of the particles will be removed prior to chlorination which should improve the chlorination process significantly (lower dose, less contact time to get equivalent kill).

Figure 1. Alternate Arrangement of Unit Processes for Phase 2 Testing



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June 12, 1998